

CHAPTER 1

INTRODUCTION

1.1 Introduction

Cranes are widely used for transportation of heavy material in factories, warehouse, shipping yards, building construction and nuclear facilities. In order to lift heavy payloads in factories, in building construction, on ships and etc, cranes usually have very strong structures.

Crane system is tends to be highly flexible in nature, generally responding to commanded motion with oscillations of the payload and hook. The response of this system to external disturbances such as wind is also oscillatory in nature. The swaying phenomenon introduce not only reduce the efficiency of the crane, but also cause safety problem in the complicated working environment.

Previously, all the cranes were manually operated. But manual operation became difficult when cranes became larger, faster and higher. Due to this, efficient controllers are applied into the cranes system to guarantee fast turn over time and to meet safety requirement.

1.2 Project Objective

There are two main objectives for this project. The first objective is to investigate the dynamic behaviour of the gantry crane system. The mathematical model of a gantry crane is obtained by Lagrangian technique. Then, MATLAB and SIMULINK are used to simulate the sway angle and trolley position of the crane system. By observing the motions of the gantry crane system, the dynamic behaviours are studied.

The second objective of this project is to develop an effective control algorithm for the crane system to reduce the oscillation or vibration of the payload and hook. Command shaping control technique is the target controller that will be studied in this project. This designed controller should be able to transfer the load from point to point as fast as possible and, at the same time, the load swing is kept small during the transfer process and completely vanishes at the load destination.

1.3 Project Scope

The scopes of this project are:

- The project topic understanding.
- Search for the relevant material.
- Study and analysis of the mathematical model of the gantry crane system.
- Simulate and investigate the dynamic performance of the gantry crane system.
- Study and understand the concept of an effective control algorithm for the gantry crane system.
- Design and develop the proposed controller mathematically.

- Implement the designed controller by MATLAB.
- Simulate the dynamic performance of the gantry crane system after the designed controller was implemented.
- Performance analysis.
- Project report write-up.

1.4 Methodology

- Gantry crane system literature review.
- Understand the mathematical model developed.
- Study the performance of the response of the gantry crane system.
- Develop effective control algorithms.
- Investigate the performance of the controllers.
- Improve the performance of the developed controllers.

1.5 Thesis Outline

This report can be divided into seven chapters. Chapter 1 is the introduction of the project objective, scope, methodology and the report outline.

Next some information about crane system and also an overview of the literature that has been published in relation to crane control will be covered in Chapter 2.

In Chapter 3 the mathematical model of a gantry crane system will be derived.

The system model will be represented in state space for analysis. Following chapter will describe how the MATLAB and SIMULINK are used to simulate the dynamic behaviors of the gantry crane. The discussion on the simulation results will be described in this chapter as well.

The development and design of the input shaping controller to reduce the vibration of the gantry crane will be included in Chapter 5. This chapter will include the discussion on the performance of the designed controller based on SIMULINK simulation result.

Non-linear gantry crane system will be studied in this project. Chapter 6 will describe the non-linear gantry crane system and its simulation results.

The last chapter, we will conclude the works done in this project and will include the suggestion for improvement.